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[Claim(s)]

[Claim 1]A gallium nitride system compound semiconductor board comprising:
The 1st gallium nitride system compound semiconductor layer whose Si doping concentration is 1x10 ^{19} / more than cm^3.
this -- the 2nd [whose non-doped one laminated on the 1st gallium nitride system compound semiconductor layer or Si doping concentration is below 1x10 ^{19}/cm^3] gallium nitride system compound semiconductor layer whose penetration dislocation density is below 1x10 ^{8}/cm^2.

[Claim 2]The gallium nitride system compound semiconductor board according to claim 1 whose penetration dislocation density of said 2nd gallium nitride system compound semiconductor layer is below 1x10 ^{6}/cm^2.
[Claim 3]The gallium nitride system compound semiconductor board according to claim 1 which the said 1st

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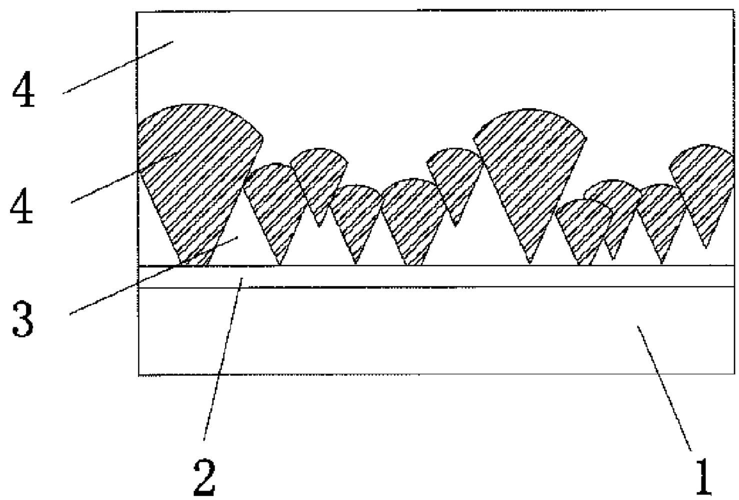

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and/or 2nd gallium nitride system compound semiconductor layer becomes from gallium nitride.
[Claim 4]The gallium nitride system compound semiconductor board comprising according to claim 1 to 3:
The 3rd gallium nitride system compound semiconductor layer whose Si doping concentration is 1x10 ^{19} / more than cm^3 on a substrate which laminated the said 1st and 2nd gallium nitride system compound semiconductor layers.
this -- the 4th gallium nitride system compound semiconductor layer whose non-doped one or Si doping concentration it laminates on the 3rd gallium nitride system compound semiconductor layer, and is below 1x10 ^{19}/cm^3.

[Claim 5]A manufacturing method of a gallium nitride system compound semiconductor board formed on a substrate characterized by comprising the following by growing up a gallium nitride system compound semiconductor layer with vapor phase growth.
The 1st process at which doping concentration of Si forms on a substrate the 1st gallium nitride system compound semiconductor layer that is 1x10 ^{19} / more than cm^3.
after the 1st process -- this -- the 2nd process of forming non-doped one or the 2nd gallium nitride system compound semiconductor layer whose doping concentration of Si is below 1x10 ^{19}/cm^3 on the 1st layer.

[Claim 6]A manufacturing method of the gallium nitride system compound semiconductor board according to claim 5 which forms the 1st gallium nitride system compound semiconductor layer in said 1st process via a foundation layer which consists of a gallium nitride system compound semiconductor on a substrate.
[Claim 7]A manufacturing method of the gallium nitride system compound semiconductor board according to claim 5 with which the said 1st and/or 2nd gallium nitride system compound semiconductor layer consists of gallium nitride.
[Claim 8]A manufacturing method of the gallium nitride system compound semiconductor board according to claim 5 characterized by comprising the following.
The 3rd process in which Si doping concentration forms the 3rd gallium nitride system compound semiconductor layer that is 1x10 ^{19} / more than cm^3 after said 2nd process.
after the 3rd process -- this -- the 4th process at which Si doping concentration forms the 4th gallium nitride system compound semiconductor layer that is below 1x10 ^{19}/cm^3 on the 3rd gallium nitride system compound semiconductor layer.

[Claim 9]A manufacturing method of the gallium nitride system compound semiconductor board according to claim

5 which uses the Silang system compound for materials of said Si doping.
[Claim 10]Said Silang system compound SiH_4, Si_2H_6, A manufacturing method of the gallium nitride system compound semiconductor board according to claim 5 which is at least one chosen from a group which comprises $SiHCl_3$, SiH_2Cl_2, SiH_3 Cl, and $SiCl_4$.
[Claim 11]A manufacturing method of the gallium nitride system compound semiconductor board according to claim 5 or 8 which is the vapor phase growth according [said vapor phase growth] to the halogen conveying method.
[Claim 12]A manufacturing method of the gallium nitride system compound semiconductor board according to claim 5, wherein said substrate is sapphire, silicon carbide, SUPINERU, or silicon.
[Claim 13]A manufacturing method of a gallium nitride system compound semiconductor board formed on a substrate characterized by comprising the following by growing up a gallium nitride system compound semiconductor layer with vapor phase growth.
The 1st process at which Si doping concentration forms on a substrate the 1st gallium nitride system compound semiconductor layer that is $1x10^{19}$ / more than cm^3 with vapor phase growth by the halogen conveying method.
after the 1st process -- this -- the 2nd process at which Si doping concentration forms the 2nd gallium nitride system compound semiconductor layer that is below $1x10^{19}/cm^3$ on the 1st gallium nitride system compound semiconductor layer.

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This inventions are a gallium nitride system compound semiconductor board and a manufacturing method for the same, and relate to the gallium nitride system compound semiconductor board which has n type conductivity which reduced especially penetration dislocation density.
[0002]
[Description of the Prior Art]Since the luminescence wavelength of a gallium nitride system compound semiconductor is a short wavelength field near 400 nm, When it can be considered as the luminescence light source of from the outside of purple until green and uses as a semiconductor laser diode, compared with the conventional red laser diode, it becomes usable as the playback

equipment of several times as many mass media, or memory storage. The application to an electron device like a field effect transistor (FET) is also expected.

[0003]In order to create such a gallium nitride system compound semiconductor device, a substrate in which gallium nitride of a bulk single crystal and homoepitaxial growth of a gallium nitride system compound semiconductor are possible is desired, but since creation of such a substrate etc. has the high steam pressure of nitrogen, it is difficult. Therefore, heteroepitaxial growth of the gallium nitride system compound semiconductor is carried out on substrates, such as sapphire, silicon carbide, SUPINERU. The gallium nitride system compound semiconductor is grown up by using this nitride semiconductor board as a substrate.

[0004]If the grating constant difference of a substrate and the gallium nitride system compound semiconductor laminated on a substrate is large, penetration transposition will occur in the gallium nitride system compound semiconductor layer laminated on a substrate. If there is much this penetration transposition, leakage current will increase, and the life characteristic is made to fall sharply in light emitting elements, such as a semiconductor laser diode. When growing up a gallium nitride system compound semiconductor on substrates, such as sapphire, penetration transposition can be reduced by passing a buffer layer. For example, the buffer layer which comprises ZnO is reported to JP,H7-202265,A and JP,H7-165498,A. In addition, the penetration dislocation densities of a certain thing also of AlN or a GaN buffer layer are 10^{8} ** / cm^2 - 10^{10} ** / cm^2 grade. In the semiconductor laser diode or high-output light emitting diode which use as an element the gallium nitride system compound semiconductor grown up on the substrate via such a buffer layer, a prolonged continuation oscillation is not expectable.

[0005]Therefore, the ELO (Epitaxial Lateral Overgrowth) method for having the effect that penetration dislocation density can be reduced more is reported. This ELO method is a reducing method of the transposition using transverse direction growth of the compound semiconductor. For example, the protective film which has an opening (window part) is formed on the gallium nitride system compound semiconductor which is a foundation layer at for example, stripe shape or island shape. Next, a gallium nitride system compound semiconductor is grown up by using as a core the gallium nitride system compound semiconductor of the foundation layer exposed from the opening of this protective film. The gallium nitride system compound semiconductor into which a foundation layer is grown up as a core grows up to be also a transverse direction after growing up to be a

lengthwise direction from an opening. This transverse direction growth is continuation growth from a core, and it grows up to be a transverse direction on a protective film. Penetration transposition grows up to be not only a lengthwise direction but a transverse direction like a gallium nitride system compound semiconductor from this. Therefore, this penetration transposition that carried out transverse direction growth is concentrated on the joined part which the gallium nitride system compound semiconductors grown-up from the core adjacent on a protective film join. Therefore, although penetration transposition is concentrated on the opening of a protective film, and the joined part on a protective film, a low transposition field can be formed in the surface of the transverse direction growth field except these fields.

[0006]

[Problem to be solved by the invention]However, it is difficult for there to be many processes, such as pattern formation of a protective film, and to mass-produce efficiently by the ELO method shown above. In order to provide an opening in a protective film by the ELO method and to grow up a gallium nitride system compound semiconductor by using as a core the gallium nitride system compound semiconductor exposed from the opening, Although a low transposition field is obtained in a transverse direction growth field, transposition concentrates on the window part upper part which is an opening, and the joined part of the gallium nitride system compound semiconductors on a protective film mostly. Therefore, it is difficult for the surface to provide the substrate which becomes uniform [a low transposition field], and a ridge stripe must be alternatively formed in a low transposition field. Therefore, on the wafer which has curvature, the yield will be reduced at the photolitho process of forming a ridge stripe. In addition, as for the nitride semiconductor board obtained by the ELO method, what has an insulating different-species board is in use, for example, it forms a nitride semiconductor on a sapphire board. Therefore, heat dissipation nature is difficult for bad high power and a prolonged continuation oscillation. Since a sapphire board is insulation, n type electrode and p type electrode must be formed on the surface, and after growing up an element, the process of forming a level difference is needed. This is disadvantageous also for reduction of a chip area as compared with the element in which the electrode was formed to the opposite-poles side. Since there is no HEKIKAI nature in a sapphire board, a dicing process is needed for separation of a chip, and a cost overrun is imitated, and it is **.

[0007]A technical problem of this invention is it being

equivalent and wide range to a gallium nitride system compound semiconductor substrate face, and obtaining a low transposition field to it. It is providing a gallium nitride system compound semiconductor board which raised mass-production efficiency by considering it as n type low resistance simple substance board which removed a different-species board.

[0008]

[Means for solving problem][a gallium nitride system compound semiconductor board of this invention] The 1st gallium nitride system compound semiconductor layer whose Si doping concentration is 1x10 ^{19} / more than cm^3, this -- non-doped one laminated on the 1st gallium nitride system compound semiconductor layer or Si doping concentration is provided with the 2nd gallium nitride system compound semiconductor layer that is below 1x10 ^{19}/ cm^3

[0009]As for a manufacturing method of a gallium nitride system compound semiconductor board in this invention, this invention is characterized by that a manufacturing method of a gallium nitride system compound semiconductor board formed on a substrate by growing up a gallium nitride system compound semiconductor layer with vapor phase growth comprises the following.

The 1st process at which Si doping concentration forms on a substrate the 1st gallium nitride system compound semiconductor layer that is 1x10 ^{19} / more than cm^3.

after the 1st process -- this -- the 2nd process at which Si doping concentration forms the 2nd gallium nitride system compound semiconductor layer that is below 1x10 ^{19}/cm^3 on the 1st layer.

[0010]Thus, Si [which are 1x10 ^{19} / more than cm^3] rich [Si doping concentration] layer, Reduction of transposition can be performed if Si doping concentration has composition which grows up Si poor layer which is below non-doped one, or 1x10 ^{19}/cm^3 on this Si rich layer. Here, with Si poor layer, it is considered as a non-doped ****** thing of Si. A Reason as for which reduction of transposition is made to below is shown. In Si rich layer, Si acts on a growth layer as a contaminant not only as a donor. Therefore, growth of a part with high Si or non-delivery density of the compound will be overdue. that is, a field where a gallium nitride system compound semiconductor grown up on a substrate has a growth rate difference -- internal division -- it becomes cloth. As a result, in the whole surface, in a portion with a quick growth rate, a core is generated alternatively and growth of an island of a gallium nitride system compound semiconductor takes place to the surface of a gallium nitride system compound

semiconductor. Next, in Si poor layer to grow up, union on the islands of said gallium nitride system compound semiconductor is promoted. This is for growing up so that a crystal grain in which a crystal grain with a quick growth rate adjoins may be covered. Here, an island of said gallium nitride system compound semiconductor has the penetration transposition extended from a growth interface of a substrate and a gallium nitride system compound semiconductor. Since the surface of an island is slope shape, it it is not only extended to a lengthwise direction, but [when an island grows this penetration transposition,] will be perpendicularly extended to a slope which is a growth side. Therefore, penetration transposition will be crooked in a process in which an island grows and unites on adjoining islands, and penetration transposition will form a loop. Therefore, in the 2nd gallium nitride system compound semiconductor layer, the penetration transposition extended in addition to a lengthwise direction in the 1st gallium nitride system compound semiconductor layer can form and reduce a loop. Since the 1st gallium nitride system compound semiconductor layer can form an interval of islands more greatly if Si doping concentration is made more than 5x10 ^{19}/cm^3, when growing up the 2nd gallium nitride system compound semiconductor layer, it can reduce transposition more. Si doping concentration of the 1st gallium nitride system compound semiconductor layer is more preferably made more than 1x10 ^{20}/cm^3. If below 1x10 ^{18}/cm^3 carry out Si doping concentration, the 2nd gallium nitride system compound semiconductor layer can improve mobility, and below 1x10 ^{17}/cm^3 will carry out Si doping concentration still more preferably. Penetration transposition is reduced in the 2nd gallium nitride system compound semiconductor layer that grows up the 1st gallium nitride system compound semiconductor layer into said gallium nitride system compound semiconductor board via a buffer layer, and is specifically grown up on it. Although penetration transposition is 1x10 ^{8} ** / cm^2 - 1x10 ^{10} ** / cm^2 grade per unit area only in having a buffer layer, Penetration dislocation density in the surface of said 2nd gallium nitride system compound semiconductor layer can be uniformly reduced by the above-mentioned composition, and below 1x10 ^{6} ** / cm^2 can make [below 1x10 ^{8} ** / cm^2] it still more desirable.

[0011]The 3rd gallium nitride system compound semiconductor layer whose Si doping concentration is 1x10 ^{19} / more than cm^3 on the 2nd gallium nitride system compound semiconductor layer, this -- non-doped one laminated on the 3rd gallium nitride system compound semiconductor layer or Si doping concentration is provided

with the 4th gallium nitride system compound semiconductor layer that is below $1x10^{19}/cm^3$
[0012]Thus, transposition can be reduced, if the composition into which Si rich layer and Si poor layer are grown up is repeated twice or more, and also when penetration transposition forms a loop. When thick film growth is carried out with the vapor phase growth by the halogen conveying method, the simple substance board which comprises only the gallium nitride system compound semiconductor layer which removed different-species boards, such as sapphire, by grinding or laser radiation can be formed. Therefore, even if it is the nitride semiconductor board grown up on an insulator like a sapphire board, since to carry out substrate removal and Si rich layer can be used as n type board of low resistance with doping Si at high concentration, it becomes possible to make an electrode into opposite-poles structure. Here, the removal process of a different-species board may be before growth of a nitride semiconductor element, or may be after growth of a nitride semiconductor element.
[0013]General formula $In_xAl_yGa_{1-x-y}N$ (0<=X<1, 0<=Y<1, 0<=X+Y<1) can show the 1st [in said gallium nitride system compound semiconductor board], and/or 2nd gallium nitride system compound semiconductor layer. If it is GaN, it has an effect which can lessen a pit in the surface after two-step growth.
[0014]The Silang system compound is used for the materials of Si doping. This Silang system compound is at least one chosen from the group which comprises SiH_4, Si_2H_6, $SiHCl_3$, SiH_2Cl_2, SiH_3 Cl, and $SiCl_4$. If these materials are used, since Si(s) or those compounds also become a dopant not only a contaminant but efficiently, it is desirable.
[0015]If said 1st gallium nitride system compound semiconductor is directly grown up on a different-species board like sapphire, dislocation density will increase from the difference in a grating constant or a thermal expansion coefficient. Therefore, by passing the buffer layer which is a foundation layer, crystallinity can be raised more rather than forming a gallium nitride system compound semiconductor layer directly on a substrate. $In_xAl_yGa_{1-x-y}N$ (0<=X<1, 0<=Y<1, 0<=X+Y<1) can show, and, specifically, it forms by low-temperature growth of 700 ** or less. As for the gallium nitride system compound semiconductor grown up only via this foundation layer, the penetration transposition per unit area serves as 10^8 - 10^{10} ** / cm^2. Therefore, a good crystalline nitride semiconductor board can be formed more by growing up Si rich layer and Si poor layer on a foundation layer.

[0016]As vapor phase growth of said gallium nitride system compound semiconductor board, there are vapor phase growth by the halogen conveying method, organic metal vapor phase growth, molecular beam epitaxy method, etc. Since the vapor phase growth by the halogen conveying method has the quick growth rate, thick film growth can be carried out and it is preferred. Other vapor phase growth, such as organic metal vapor phase growth, molecular beam epitaxy method, etc. which are easy to control transverse direction growth by a thin film to realize low defect-ization, may be used.

[0017]Gallium nitride system compound semiconductor machine In the manufacturing method of a board, sapphire, silicon carbide, SUPINERU, or silicon is mentioned to a substrate. These can grow a gallium nitride system compound semiconductor epitaxially, and have heat resistance to growth temperature. Exfoliation removal of the substrate by grinding, electromagnetic irradiation, etc. is enabled after laminating a gallium nitride system compound semiconductor layer, and the simple substance board which consists of a gallium nitride system compound semiconductor by this can be formed. In this invention, since the 1st gallium nitride system compound semiconductor layer is made into Si rich layer, a substrate removal side can be made into n type nitride semiconductor layer. Therefore, in the good crystalline nitriding thing simple substance board which reduced penetration transposition, the gallium nitride system compound semiconductor laser which carried out opposite-poles formation of the electrode, or a light emitting diode can be provided.

[0018]

[Mode for carrying out the invention][a gallium nitride system compound semiconductor board concerning an embodiment of this invention] The 1st gallium nitride system compound semiconductor layer 3 whose Si doping concentration is 1x10 ^{19} / more than cm^3, this -- non-doped one laminated on the 1st gallium nitride system compound semiconductor layer or Si doping concentration is a gallium nitride system compound semiconductor board provided with the 2nd gallium nitride system compound semiconductor layer 4 that is below 1x10 ^{19}/cm^3.

[0019]It is at least one chosen as said Si materials from a group to which these Silang system compounds change from SiH_4, Si_2H_6, $SiHCl_3$, SiH_2Cl_2, SiH_3 Cl, and $SiCl_4$ using the Silang system compound.

[0020]Said 1st gallium nitride system compound semiconductor and the 2nd gallium nitride system compound semiconductor make a general formula

$In_xAl_yGa_{1-x-y}N$ (0<=X<1, 0<=Y<1, 0<=X+Y<1).

[0021]The invention in an one effect embodiment can perform Si dope simultaneously with growth of a gallium nitride system compound semiconductor, and can produce a gallium nitride system compound semiconductor board which makes the surface flat because two steps grow, and has a low defective field broadly. It is based on a natural operation of a crystal which carries out transverse direction growth that such flat-ization can be performed. In a gallium nitride system compound semiconductor board shown in this embodiment, transposition is not reduced as a reducing method of transposition, without embedding a facet, it is made to grow up, embedding a facet and transposition is reduced. As mentioned above, it is not necessary to carry out flat-ization by surface polish etc., and a gallium nitride system compound semiconductor board can be formed efficiently.

[0022]Effect 2 this invention can form n type simple substance board of low resistance by removing a substrate. In a reduction process of transposition, this is because an n-type semiconductor layer of low resistance can be formed in order to dope Si continuously in a gallium nitride system compound semiconductor layer. For this reason, it can be considered as structure which formed an electrode in the opposite poles, and is advantageous to reduction of a chip area. Since there are no different-species boards, such as a sapphire board, it is [a dicing process] less necessary for separation of a chip, and leads also to reduction of cost. When it has cleavability and forms a semiconductor laser, the simple substance board which comprises a gallium nitride system compound semiconductor can use a cleaved surface as a resonator mirror, and is preferred. By removing a substrate, since heat dissipation nature also improves, reinforcement is expectable.

[0023]Although a manufacturing process of a gallium nitride system compound semiconductor board in one embodiment of this invention is shown below, it is not limited to this.

[0024]In this invention, the substrate should just be a single crystal board which can grow a nitride semiconductor layer epitaxially, and in particular a size, thickness, etc. of a substrate are not limited. As an example of this substrate, either C side, R side and A side are made into the principal surface, Sapphire and SUPINERU into which a nitride semiconductor layer of c-axis orientation is grown up preferably, silicon carbide (6H, 4H, 3C), silicon, ZnS, ZnO, SiO_2, GaAs, GaP, a diamond, $NdGaO_3$, other nitride semiconductors, etc. are mentioned. Substrates, such as sapphire, may be removed after laminating a gallium nitride

system compound semiconductor layer. Although these substrates use what has the flat surface, if a gallium nitride system compound semiconductor layer can be grown epitaxially, they will not be limited in particular. For example, fine roughness is formed in the back of a substrate by carrying out etching processing etc. Substrate removal can be simplified by this roughness. In order to ease curvature, it may have air bridge structure in a substrate at unevenness, a slope, the shape of an echelon form, and others.

[0025]The 1st gallium nitride system compound semiconductor is grown up [on the foundation layer 2 aforementioned board] via an $In_xAl_yGa_{1-x-y}N$ (0<=X<1, 0<=Y<1, 0<=X+Y<1) layer as a buffer layer at low temperature 800 ** or less. This is for controlling a defect and a crack by easing the grating constant mismatching of a substrate and a gallium nitride system compound semiconductor. Here, the temperature ranges of 700 ** or less of low temperature are 450 ** - 650 ** preferably. If a buffer layer is grown up at the temperature within the limits of this, a detailed core can be formed with sufficient homogeneity and it is desirable. If a buffer layer is grown up above 800 **, uniform nuclear generation is checked, and since a crystal many crystallizes after that, crystallinity will be reduced. Film thickness is grown up at 10 A or more 0.5 micrometer or less. A foundation layer is good also not only as a buffer layer but a two-layer structure. This is for considering it as the foundation layer which the surface is a specular surface and made flat by growing up the 2nd foundation layer at not less than 950 ** high temperature on a buffer layer (the 1st foundation layer). From this, generating of the pit in the gallium nitride system compound semiconductor grown up at a back process can be controlled. This foundation layer is also omissible depending on a substrate.

[0026]The 1st gallium nitride system compound semiconductor and the 2nd gallium nitride system compound semiconductor are grown up after forming the foundation layer 2 on a gallium nitride system compound semiconductor, next said substrate 1. This gallium nitride system compound semiconductor can be denoted by general formula $In_xAl_yGa_{1-x-y}N$ (0<=X<1, 0<=Y<1, 0<=X+Y<1). However, these may be mutually different composition. It is good also as a gallium nitride system compound semiconductor which could use O or germanium, Sn, S, etc. as a dopant besides Si, and made these dope p type impurities. As for p type impurities, Mg, Be, Cr, Mn, Ca, Zn, etc. are mentioned.

[0027]The film thickness of the 1st gallium nitride system

compound semiconductor layer may be not less than 5 micrometers. It may be not less than 15 micrometers preferably. This is because penetration transposition cannot be made crooked broadly if the film thickness of the 1st gallium nitride system compound semiconductor layer is 5 micrometers or less. The direction where penetration transposition is extended after growing up the 1st gallium nitride system compound semiconductor layer can be made crooked by growing up the 1st gallium nitride system compound semiconductor layer by this film thickness. Next, if not less than 15 micrometers of 2nd gallium nitride system compound semiconductor layer grown up on said 1st gallium nitride system compound semiconductor layer is grown up preferably, [layer] [not less than 5 micrometers of film thickness] Penetration transposition can be reduced by making a loop form by penetration transposition at the time of growth of the 2nd gallium nitride system compound semiconductor layer.

[0028]How to grow up the 1st gallium nitride system compound semiconductor and the 2nd gallium nitride system compound semiconductor by the gaseous phase growing (HVPE) method by the halogen conveying method via a foundation layer as a manufacturing method of a gallium nitride system compound semiconductor board on a substrate is shown below. Since the halide gaseous phase growing method can grow up a thick film for a short time, it is effective in thick film growth of a nitride semiconductor, and formation of the simple substance board of the nitride semiconductor which exfoliated the different-species board. The growth technique and the growth process of having used for below by this invention, and growth conditions are shown.

[0029]The halogenation thing of an III fellows element and the compound (compound which contains nitrogen in this invention) containing V fellows element are made to react as 1 vapor-phase-epitaxy means in this invention, The vapor-phase-epitaxy (halogen-transport vapor phase epitaxy: HVPE) method by the halogen conveying method for performing vapor phase epitaxy on a substrate is raised.

[0030]There are HCl etc. as halogen gas and it is introduced from a halogen gas pipe with carrier gas. When metal, such as Ga, reacts to this halogen gas, the halogenation thing of 3 fellows element is made to generate, and when the ammonia gas which flowed from the source feed pipe of N reacts further, a gallium nitride system compound semiconductor is grown up on a substrate. In the HVPE method, in the atmosphere containing reducing gas (for example, hydrogen), since the whole reaction pipe is heated by resistance heating, the Silang system gas which is dopant gas is decomposed, before arriving at a substrate field, it

decomposes, and doping of effectual Si is difficult. Therefore, by introducing dopant gas and HCl simultaneously, decomposition of Silang system gas is controlled and a dope is efficiently possible.
[0031]As growth conditions for the 1st gallium nitride system compound semiconductor, a growth rate should just be 5 or more micrometer/hour. The 1st gallium nitride system compound semiconductor and the 2nd gallium nitride system compound semiconductor can make a growth rate the same speed. Therefore, distortion generated in an interface according to a crystalline difference produced when growth rates differ can be eased. Here, the 1st gallium nitride system compound semiconductor is preferably grown up by normal pressure or fine decompression.
[0032]Next, the 2nd gallium nitride system compound semiconductor is grown up on condition of the following on this after growing up the 1st gallium nitride system compound semiconductor.
[0033]As for the 2nd gallium nitride system compound semiconductor, it shall be preferred to make it grow up at the 1st gallium nitride system compound semiconductor, the **, or temperature beyond it, and it shall be not less than 900 ** in substrate temperature. However, since remains heat distortion will occur in a growth boundary side if a difference in temperature with the 1st gallium nitride system compound semiconductor and the 2nd gallium nitride system compound semiconductor is large, a direction with few differences in temperature is preferred. As film thickness of the 2nd gallium nitride system compound semiconductor, especially if an uppermost surface turns into a specular surface, it will not be limited, but what is necessary is just not less than 15 micrometers. Therefore, if the 2nd gallium nitride system compound semiconductor is the vapor phase growth which can grow about 15 micrometers, it can perform film thickness with the MOCVD method or other vapor phase growth. It is preferred to use the MOCVD method for control of the homogeneity of core density of a crystal, the characteristic for ** and a size, and thickness of a layer.
[0034]It becomes flat [a gallium nitride system compound semiconductor board obtained by the above-mentioned growing method / an uppermost surface] with a gallium nitride system compound semiconductor board which is wide range and has a low defective portion used as a specular surface. As long as an element formed on a gallium nitride system compound semiconductor board obtained by this invention uses a gallium nitride system compound semiconductor, a light emitting element, a photo acceptance unit, or an electron device may be sufficient as it. A semiconductor laser element which formed an electrode on

the same field as a light emitting element in this embodiment is shown in drawing 3. A semiconductor laser element which formed an electrode as an opposite-poles structure is shown in drawing 4.

[0035]As mentioned above, a gallium nitride system compound semiconductor board obtained shall have the 2nd gallium nitride system compound semiconductor layer whose penetration dislocation density of below $1x10^8/cm^2$ is below $1x10^7/cm^2$ more preferably.

[0036]

[Working example]Hereafter, the work example in this invention is described.

[Work example 1] First, it set in the MOCVD device, thermal cleaning for 10 minutes was performed at the temperature of 1050 ** using the sapphire board which makes C side the principal surface as the substrate 1, and the adhesion thing of moisture or the surface was removed.

[0037]Next, the foundation layer was grown up with two-layer structure. First, temperature was 510 **, hydrogen was used for carrier gas, ammonia and trimethylgallium were used for material gas, and the buffer layer which comprises GaN was grown up by 200-A film thickness. Next, the layer which comprises GaN on a buffer layer and has flat nature was formed by 3 micrometers of film thickness at the growth temperature of 1050 **. In this example, ammonia was passed for hydrogen as carrier gas at the time of growth, and a part for 5L/and trimethylgallium were passed in between by 25-cc/as a part for 20.5L/, and material gas.

[0038]After growing up a foundation layer on a substrate, in order to grow up the 1st gallium nitride system compound semiconductor and the 2nd gallium nitride system compound semiconductor, it sets in a HVPE device.

[0039]First, GaCl is generated by preparing Ga metal for a boat, using nitrogen and/or hydrogen for carrier gas as a source of Ga, and passing the HCl gas which is halogen gas. By using nitrogen and/or hydrogen for carrier gas, and passing the ammonia gas which is a source of N, GaCl and ammonia gas are made to react and GaN is formed in a substrate field. It dopes by using nitrogen and/or hydrogen for carrier gas, and passing $SiCl_4$, and the 1st gallium nitride system compound semiconductor that consists of the Si dope GaN is grown up on a substrate. The temperature of the substrate field was set as 1030 ** with the electric furnace. GaCl partial pressure set $1.25x10^{-3}$atm and NH_3 partial pressure to 0.375atm by making the growth rate of the 1st gallium nitride system compound semiconductor into 50 micrometer/hour. $SiCl_4$ partial pressure was set to $2.87x10^{-7}$atm. This 1st gallium nitride system compound

semiconductor was grown up by 50 micrometers of film thickness.
[0040]Next, the 2nd gallium nitride system compound semiconductor was grown up in the gaseous phase growing method device by the halogen conveying method on the 1st gallium nitride system compound semiconductor. In growth conditions, as growth conditions at this time, film thickness grew up the 2nd gallium nitride system compound semiconductor at 100 micrometers by growth rate 50 micrometer/hour like the 1st gallium nitride system compound semiconductor except having set $SiCl_4$ partial pressure to $1.0x10^{-8}$atm.
[0041]The surface of the 2nd gallium nitride system compound semiconductor board obtained by the above turns into flatness and a specular surface, In SIMS analysis, the 1st gallium nitride system compound semiconductor layer of Si concentration was $2x10^{19}/cm^2$, and the 2nd gallium nitride system compound semiconductor layer was $2x10^{18}/cm^2$. The gallium nitride system compound semiconductor board which penetration dislocation density is a $2x10^{7}cm^{-2}$ grade according to CL observation as shown in drawing 2, and is a low defect can be provided.
[0042][Work example 2] The 3rd gallium nitride system compound semiconductor layer and the 4th gallium nitride system compound semiconductor layer are grown up on the gallium nitride system compound semiconductor board obtained in above-mentioned work example 1. This 3rd gallium nitride system compound semiconductor layer makes the same the 1st gallium nitride system compound semiconductor layer and growth conditions, and the 4th gallium nitride system compound semiconductor layer makes the same the 2nd gallium nitride system compound semiconductor layer and growth conditions.
[0043]As mentioned above, since the obtained gallium nitride system compound semiconductor board turns into a substrate of low transposition which carried out thick film growth, it can be used as the simple substance board which removed the different-species board.
[0044][Work example 3] From the gallium nitride system compound semiconductor board obtained by the work example 1, grinding removes a sapphire board and it is considered as the simple substance board of GaN. A laser device is formed on this simple substance board.
[0045](n type contact layer 102) First, set the simple substance board of GaN to the reaction vessel of a MOCVD device, and TMG, n type contact layer 102 which consists of $aluminum_{0.05}Ga_{0.95}N$ which carried out Si dope at 1050 ** is grown up by 4-micrometer film thickness, using Silang Guth as TMA, ammonia, and impurities gas.

[0046]The crack prevention layer 103 which shall be 900 ** in temperature and consists of $In_{0.07}Ga_{0.93}N$ is grown up by 0.15 micrometer of film thickness using the (crack prevention layer 103) next TMG, TMI (trimethylindium), and ammonia. This crack prevention layer is omissible.
[0047](n type cladding layer 104), next temperature shall be 1050 **, and to material gas TMA, A layer which consists of undoped $aluminum_{0.05}Ga_{0.95}N$ is grown up by 25-A film thickness using TMG and ammonia, Then, TMA is stopped and B layer which consists of GaN which cm^{-3}[5x10 ^{18}/]-doped Si is grown up by 25-A film thickness, using Silang Guth as impurities gas. This operation is made into the lamination structure of a 200 times repetition A layer and B layer, and n type cladding layer which consists of a multilayer film (supperlattice structure) of 1 micrometer of the total film thickness is grown up.
[0048]TMG and ammonia are used for material gas at (n type guide layer 105), next same temperature, and n type guide layer 105 which consists of undoped GaN is grown up by 0.15 micrometer of film thickness. This n type guide layer 105 may dope n type impurities.
[0049]The (active layer 106), next temperature shall be 900 **, and to material gas TMI (trimethylindium), Silang Guth is used as impurities gas using TMG and ammonia, A barrier layer which consists of $In_{0.05}Ga_{0.95}N$ which cm^{-3} [5x10 ^{18}/]-doped Si 140-A film thickness, A well layer which stops Silang Guth and consists of undoped $In_{0.13}Ga_{0.87}N$, [40-A film thickness] It laminates in order of a barrier layer / well layer / barrier layer / well layer, and finally, as a barrier layer, TMI, TMG, and ammonia are used and undoped $In_{0.05}Ga_{0.95}N$ is grown up. The active layer 106 serves as multiquantum well structure (MQW) of 500 A of the total film thickness.
[0050]At the same temperature as (p type electronic confining layer 107), next an active layer, to material gas TMA, Cp_2Mg (magnesium cyclopentadienyl) is used as impurities gas using TMG and ammonia, p type electronic confining layer 107 which consists of $aluminum_{0.3}Ga_{0.7}N$ which cm^{-3}[1x10 ^{19}/]-doped Mg is grown up by 100-A film thickness.
[0051](p type guide layer 108), next temperature shall be 1050 **, TMG and ammonia are used for material gas, and p type guide layer 108 which consists of undoped GaN is grown up by 0.15 micrometer of film thickness. This p type guide layer may dope p type impurities.
[0052](p type cladding layer 109), next A layer which consists of undoping $aluminum_{0.05}Ga_{0.95}N$ at 1050 ** are

grown up by 25-A film thickness, Then, TMA is stopped, B layer which consists of the Mg dope GaN is grown up by 25-A film thickness using Cp_2Mg, and p type cladding layer 109 which repeats it 90 times and consists of a super-latticed layer of 0.45 micrometer of the total film thickness is grown up. p type cladding layer is taken as the supperlattice structure which laminated GaN and AlGaN. Since the refractive index of the cladding layer itself becomes small since aluminum mix crystal ratio of the whole cladding layer can be raised by making p type cladding layer 109 into supperlattice structure, and also bandgap energy becomes large, it is very effective when reducing a threshold.

[0053](p type contact layer 110) p type contact layer 110 which consists of p type GaN which used TMG, ammonia, and Cp_2Mg and finally cm^{-3}[$1x10^{20}$/]-doped Mg on p type cladding layer 109 at 1050 ** is grown up by 150-A film thickness. After the end of a reaction, and in a reaction vessel, annealing is performed for a wafer at 700 ** among a nitrogen atmosphere, and p type layer is low-resistance-ized further.

[0054]Take out after annealing a simple substance board which comprises GaN which made a nitride semiconductor laser device laminate from a reaction vessel, and a protective film which consists of SiO_2 is formed in the surface of p type contact layer of the top layer, By etching by CF_4 gas using RIE (reactant ion etching), a ridge stripe is formed as a stripe-like waveguide way field.

[0055]Next, it forms by 0.5 micrometer of film thickness after ridge stripe formation on p type guide layer 108 which exposed an insulating protective film which consists of a Zr oxide (mainly ZrO_2) by etching.

[0056]p type electrode is formed from nickel and Au on p type contact layer. Here, as film thickness of p type electrode, nickel shall be 100 A and Au shall be 1300 A. n type electrode is formed in the 1st gallium nitride system compound semiconductor layer that becomes the back so that the opposite poles may be carried out to p type electrode from Ti and aluminum. Ti makes 200 A and aluminum 8000-A film thickness. Stripe formation of this p type electrode is carried out on a ridge.

n type electrode by which stripe formation is similarly carried out is the opposite poles, and it forms in a parallel direction.

Next, a pad electrode is formed on p type electrode and n type electrode, respectively. On p type electrode, RhO (oxidization rhodium)/Pt/Au is formed as a p type pad electrode by film thickness of (1500 A to 3000A - 6000 A). On n type electrode, nickel/Ti/Au is formed as an n type pad

electrode by film thickness of (1000 A to 1000A - 8000 A).
[0057]It acts as Sklar Eve after electrode formation and of the n type electrode side, and **** in the shape of a bar in a direction perpendicular to a ridge stripe, and the dielectric multilayer which becomes a cleaved surface from SiO_2 and TiO_2 is formed as a resonator mirror. Then, in a direction parallel to a ridge stripe, a bar is cut and it is considered as a laser chip.
[0058]The laser device of a continuation oscillation with an oscillation wavelength of 405 nm is obtained [in / on room temperature and / in the laser device produced by making it above / threshold 2.8 kA/cm^2 and a 5-60-mW output]. The element life of the laser device obtained shows 1000 to 30000 hours.
[0059][Work example 4] From the gallium nitride system compound semiconductor board obtained by the work example 1, grinding removes a sapphire board and it is considered as the simple substance board of GaN. The laser device in which n type electrode and p type electrode were formed on the same field on this simple substance board is created.
[0060]First, set a GaN board in the reaction vessel of a MOCVD device, and at 1050 **, [a nitride semiconductor] The undoping n type contact layer 101 which consists of aluminum$_{0.05}$Ga$_{0.95}$N is grown up by 1 micrometer of film thickness using TMG (trimethylgallium), TMA (trimethyl aluminum), and ammonia. This layer has a function as a buffer layer among semiconductor devices including the nitride semiconductor board and n type contact layer which consist of GaN(s). However, this undoping n type contact layer is also omissible.
[0061]Next, . [an undoping n type contact layer] p type guide layer 108 / n type contact layer 102 / 104/of 103/of crack prevention layer n type cladding layer n type guide layer 105 / active layer 106 / p type electronic confining layer 107 / p type cladding layer 109 / p type contact layer 110 is further grown up on the conditions as the work example 3 that it is the same after growth.
[0062]Then, ridge stripe formation is carried out at ridge 1.7 micrometers in width. Next, n type contact layer is exposed by etching. Then, film thickness is formed at 0.5 micrometer or less on p type guide layer 108 which exposed the insulating protective film which consists of a Zr oxide (mainly ZrO_2) by etching. Then, p type electrode is formed from nickel and Au on p type contact layer exposed to stripe shape. Here, it is referred to as nickel (100A) and Au (1300A) as film thickness of p type electrode. After forming p type electrode, n type electrode is formed on said exposed

n type contact layer. This n type electrode forms Ti/ aluminum in parallel on the same field as p type electrode by film thickness (200A - 8000 A). A pad electrode is formed on p type electrode and n type electrode, respectively. On p type electrode, RhO(oxidization rhodium)/Pt/Au is formed as a p type pad electrode by the film thickness of (1500 A to 3000A - 6000 A). On n type electrode, nickel/Ti/Au is formed as an n type pad electrode by the film thickness of (1000 A to 1000A - 8000 A).
[0063]It acts as Sklar Eve of the back side of a substrate after electrode formation, and **** in the shape of a bar in a direction perpendicular to a ridge stripe, and the dielectric multilayer which becomes a cleaved surface from SiO_2 and TiO_2 is formed as a resonator mirror. Then, in a direction parallel to a ridge stripe, a bar is cut and it is considered as a laser chip.
[0064]The laser device of a continuation oscillation with an oscillation wavelength of 405 nm is obtained [in / on room temperature and / in the laser device produced by making it above / threshold 2.8 kA/cm^2 and a 5-60-mW output]. The element life of the laser device obtained will be 1000 to 30000 hours.
[0065][Work example 5] A laser device is formed on a gallium nitride system compound semiconductor board with the sapphire obtained by the work example 1. First, the undoping n type contact layer 101 is grown up on said substrate. Set a substrate in the reaction vessel of a MOCVD device, and at 1050 **, [a nitride semiconductor] The undoping n type contact layer 101 which consists of aluminum$_{0.05}$Ga$_{0.95}$N is grown up by 1 micrometer of film thickness using TMG (trimethylgallium), TMA (trimethyl aluminum), and ammonia. This layer has a function as a buffer layer among semiconductor devices including the nitride semiconductor board and n type contact layer which consist of GaN(s).
[0066]Next, element formation is performed in following order on the same conditions as a work example 3. . [an undoping n type contact layer] It is made to grow up on a substrate grown up in order of p type guide layer 108 / n type contact layer 102 / 104/of 103/of crack prevention layer n type cladding layer n type guide layer 105 / active layer 106 / p type electronic confining layer 107 / p type cladding layer 109 / p type contact layer 110.
[0067]Then, ridge stripe formation is carried out at ridge 1.7 micrometers in width. Next, n type contact layer is exposed by etching. Then, film thickness is formed at 0.5 micrometer or less on p type guide layer 108 which exposed an insulating protective film which consists of a Zr oxide

(mainly ZrO_2) by etching. Then, p type electrode is formed from nickel and Au on p type contact layer exposed to stripe shape. Here, it is referred to as nickel (100A) and Au (1300A) as film thickness of p type electrode. After forming p type electrode, n type electrode is formed on said exposed n type contact layer. This n type electrode forms Ti/ aluminum in parallel on the same field as p type electrode by film thickness (200A - 8000 A). A pad electrode is formed on p type electrode and n type electrode, respectively. On p type electrode, RhO(oxidization rhodium)/Pt/Au is formed as a p type pad electrode by film thickness of (1500 A to 3000A - 6000 A). On n type electrode, nickel/Ti/Au is formed as an n type pad electrode by film thickness of (1000 A to 1000A - 8000 A).
[0068]Dicing of the back side of a substrate is carried out after electrode formation, it **** in the shape of a bar in a direction perpendicular to a ridge stripe, and the dielectric multilayer which becomes a cleaved surface from SiO_2 and TiO_2 is formed as a resonator mirror. Then, in a direction parallel to a ridge stripe, a bar is cut and it is considered as a laser chip. As mentioned above, the element life of the obtained laser device will be 500 to 10000 hours.
[0069][Work example 6] A laser device is formed on a gallium nitride system compound semiconductor board with the sapphire obtained by the work example 1. First, the undoping n type contact layer 101 is grown up on said substrate. Set a substrate in the reaction vessel of a MOCVD device, and at 1050 **, [a nitride semiconductor] The undoping n type contact layer 101 which consists of aluminum$_{0.05}$Ga$_{0.95}$N is grown up by 1 micrometer of film thickness using TMG (trimethylgallium), TMA (trimethyl aluminum), and ammonia. This layer has a function as a buffer layer among semiconductor devices including the nitride semiconductor board and n type contact layer which consist of GaN(s).
[0070][on the substrate into which the first half undoping n type contact layer 101 was grown up] A semiconductor device is grown up on the work example 3 and the conditions in order of p type guide layer 108 / n type contact layer 102 / 104/of 103/of crack prevention layer n type cladding layer n type guide layer 105 / active layer 106 / p type electronic confining layer 107 / p type cladding layer 109 / p type contact layer 110.
[0071]Next, grinding removes a sapphire board and ridge stripe formation is further carried out at ridge 1.7 micrometers in width. Next, n type contact layer is exposed by etching. Then, film thickness is formed at 0.5 micrometer or less on p type guide layer 108 which exposed an

insulating protective film which consists of a Zr oxide (mainly ZrO_2) by etching. Then, p type electrode is formed from nickel and Au on p type contact layer exposed to stripe shape. Here, it is referred to as nickel (100A) and Au (1300A) as film thickness of p type electrode. After forming p type electrode, n type electrode is formed on said exposed n type contact layer. This n type electrode forms Ti/aluminum in parallel on the same field as p type electrode by film thickness (200A - 8000 A). A pad electrode is formed on p type electrode and n type electrode, respectively. On p type electrode, RhO(oxidization rhodium)/Pt/Au is formed as a p type pad electrode by film thickness of (1500 A to 3000A - 6000 A). On n type electrode, nickel/Ti/Au is formed as an n type pad electrode by film thickness of (1000 A to 1000A - 8000 A).

[0072]It acts as Sklar Eve of the back side of a substrate after electrode formation, and **** in the shape of a bar in a direction perpendicular to a ridge stripe, and a dielectric multilayer which becomes a cleaved surface from SiO_2 and TiO_2 is formed as a resonator mirror. Then, in a direction parallel to a ridge stripe, a bar is cut and it is considered as a laser chip. As mentioned above, an element life of an obtained laser device will be 1000 to 30000 hours.

[0073][A work example 7] In the above-mentioned work examples 3-6, n type electrode Ti/aluminum (200A - 8000 A), A laser device is formed on the conditions except making nickel/Au (100A - 1500 A), n type pad electrode, and p type pad electrode into nickel/Ti/Au (1000 A to 1000A - 8000 A) for p type electrode. The life characteristic of a laser device obtained here will be 500 to 10000 hours.

[0074][A work example 8] Make C side into the principal surface and a sapphire board which makes a cage hula side A side is used for the substrate 1, On the substrate 1, a protective film which consists of SiO_2 with a CVD method is formed by 0.5 micrometer of film thickness, a stripe-like photomask is formed, and a protective film which consists of SiO_2 of stripe 14 micrometers in width, and 6 micrometers of window parts by etching is formed. Let the direction of a stripe of this protective film be a perpendicular direction to a sapphire A side.

[0075]Next, by the MOCVD method, temperature is used for 510 ** and carrier gas, ammonia and TMG (trimethylgallium) are used for hydrogen and material gas, and a buffer layer which comes from gallium nitride on an opening of a protective film is grown up by 200-A film thickness. Then, by the MOCVD method, temperature shall be 1050 ** on decompression conditions, TMG, ammonia, Silang Guth, and Cp_2Mg (magnesium cyclopentadienyl) are

used for material gas, and the 1st nitride semiconductor layer that consists of gallium nitride is grown up by 10-micrometer film thickness. At this time, the 1st nitride semiconductor makes an opening of a protective film which comprises SiO_2 a growth starting point, and it forms it so that section shape of the 1st nitride semiconductor layer may become T type-like.

[0076]Next, by isotropic etching which is dry etching, at temperature of 120 **, oxygen and CF_4 are used for etching gas and a SiO_2 protective film is removed. From the 1st side and upper surface of a nitride semiconductor that carried out transverse direction growth, by normal pressure with the MOCVD method, Temperature shall be 1050 **, TMG, ammonia, Silang Guth, and Cp_2Mg (magnesium cyclopentadienyl) are used for material gas, and the 2nd nitride semiconductor layer that consists of gallium nitride is grown up by 15-micrometer film thickness.

[0077]As mentioned above, in order to grow up the 1st gallium nitride system compound semiconductor and the 2nd gallium nitride system compound semiconductor on an obtained substrate, it sets in a HVPE device. GaCl is generated by preparing Ga metal for a boat, using nitrogen and/or hydrogen for carrier gas as a source of Ga, and passing HCl gas which is halogen gas. By using nitrogen and/or hydrogen for carrier gas, and passing ammonia gas which is a source of N, GaCl and ammonia gas are made to react and GaN is formed in a substrate field. It dopes by using nitrogen and/or hydrogen for carrier gas, and passing $SiCl_4$, and the 1st gallium nitride system compound semiconductor that consists of the Si dope GaN is grown up on a substrate. Temperature of a substrate field is set as 1030 ** with an electric furnace. GaCl partial pressure sets $1.25x10^{-3}$atm and NH_3 partial pressure to 0.375atm by making a growth rate of the 1st gallium nitride system compound semiconductor into 50 micrometer/hour. $SiCl_4$ partial pressure is set to $2.87x10^{-7}$atm. This 1st gallium nitride system compound semiconductor is grown up by 50 micrometers of film thickness.

[0078]Next, the 2nd gallium nitride system compound semiconductor is grown up in the gaseous phase growing method device by the halogen conveying method on the 1st gallium nitride system compound semiconductor. In growth conditions, as growth conditions at this time, film thickness grows up the 2nd gallium nitride system compound semiconductor at 100 micrometers by growth rate 50 micrometer/hour like the 1st gallium nitride system compound semiconductor except having set $SiCl_4$ partial

pressure to $1.0x10^{-8}$atm.
[0079]the surface of the 2nd gallium nitride system compound semiconductor board obtained by the above turns into flatness and a specular surface, and, below in $1x10^{7}cm^{-2}$, penetration dislocation density becomes -- low -- a defect gallium nitride system compound semiconductor board can be provided.
[0080][Work example 9] In the above-mentioned work example, a gallium nitride system compound semiconductor board is formed on the conditions except growing up the 2nd gallium nitride system compound semiconductor by growth rate 100 micrometer/hour by making the growth rate of the 1st gallium nitride system compound semiconductor into 50 micrometer/hour. the surface of the 2nd gallium nitride system compound semiconductor board obtained by the above turns into flatness and a specular surface, and, below in $1x10^{8}cm^{-2}$, penetration dislocation density becomes -- low -- a defect gallium nitride system compound semiconductor board can be provided.
[0081]
[Effect of the Invention]As mentioned above, in this invention, not the transverse direction growth board that used the protective film etc. but the low defective board which reduced the crystal defect of the whole substrate surface can be provided. Therefore, a device process can be simplified compared with the substrate obtained by the ELO method, and the gallium nitride system compound semiconductor board which raised mass-production efficiency can be provided. Since it can also be considered as the simple substance board of the low resistance which comprises a nitriding thing by removing a substrate, heat dissipation nature can improve and the life characteristic of a nitride semiconductor element can be improved. The electrode structure which carried out the opposite poles becomes possible, and it becomes advantageous also to reduction of a chip area.
[0082]

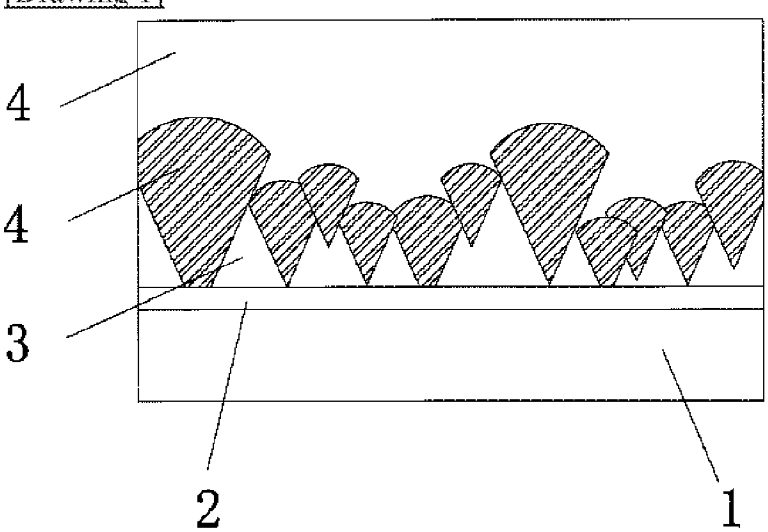
[Brief Description of the Drawings]
[Drawing 1]It is a ** type sectional view of the nitride semiconductor in which the 1 embodiment of this invention is shown.
[Drawing 2]It is CL photograph in the work example 1 of this invention.
[Drawing 3]It is a ** type sectional view of the nitride semiconductor laser device in the 1 embodiment of this invention.
[Drawing 4]It is a ** type sectional view of the nitride

semiconductor laser device in the 1 embodiment of this invention.

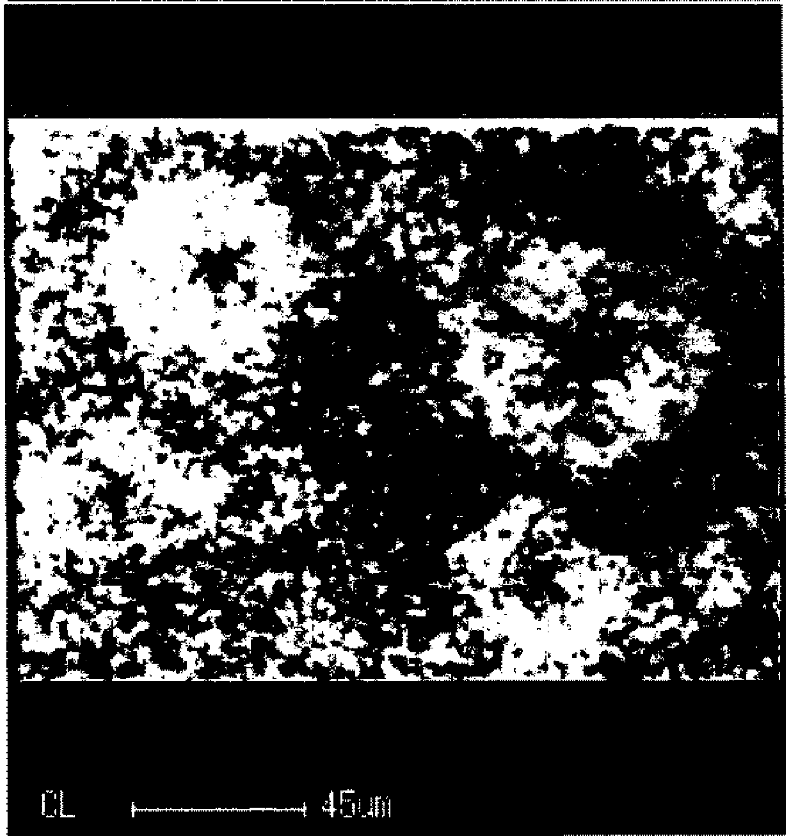
[Brief Description of Notations]

1 ... Substrate
2 ... Foundation layer
3 ... the -- the gallium nitride system compound semiconductor of one
4 ... the -- the gallium nitride system compound semiconductor of two
101 ... Undoping n type contact layer
102 ... n type contact layer
103 ... Crack prevention layer
104 ... n type cladding layer
105 ... n type guide layer
106 ... Active layer
107 ... p type electronic confining layer
108 ... p type guide layer
109 ... p type cladding layer
110 ... p type contact layer

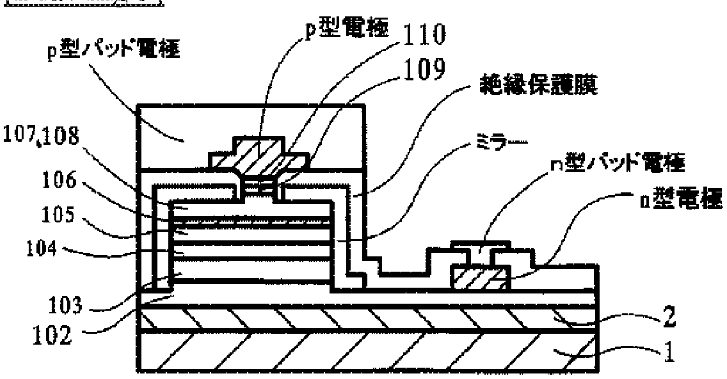
[Drawing 1]



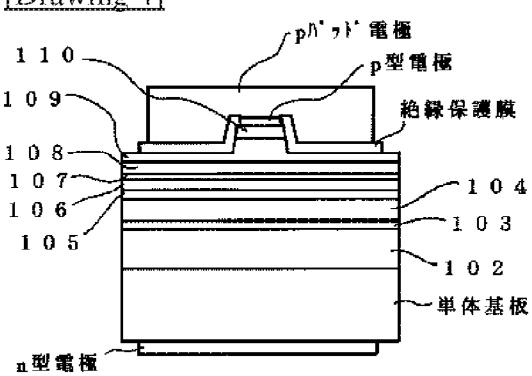
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]

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